Identifying conservation priorities in the Meres & Mosses Natural Area by using axiophytes

Alex Lockton, Dan Wrench, Sarah Whild, Iain Diack & Frances McCullagh
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Introduction

The purpose of this report is to explore the use of axiophytes as a mechanism to provide information that will help to focus conservation effort and resources within the Meres & Mosses Natural Area.

The most important features of the Meres & Mosses NA are considered to be its wetlands, which include fens, mires and standing open water. Traditionally, sites are notified for the presence of these habitats and for rare species that occur in them. However, identifying habitats and determining their quality is a largely subjective process that is very difficult to quantify, and there are very few rare species in the Meres & Mosses area. Moreover, it is almost impossible to detect and act on changes in a site by examining only its rare species, which may often be represented by just a single plant, or perhaps just a very few. By the time the rarities have been influenced by any change in the ecology, it is usually too late to take any action.

Axiophytes represent an alternative approach to site notification and monitoring. An axiophyte is a species that is indicative of favourable conservation status. In effect, if an axiophyte grows well on a site, then that site is in favourable condition for the feature that is indicated. For example, an axiophyte of lowland raised mires may not be particularly rare, but it will be a plant that is known in this region to flourish only on such mires. By measuring the distribution and abundance of many such species across time, any changes in the state of the mires will be revealed.

This report is an experimental study of the use of axiophyte data to define and quantify conservation objectives and actions. The aim is to provide empirical evidence that can quantify and support planning and future action in the region. If successful, it is an approach that could be continued and enhanced within this region and possibly extended to other regions throughout Britain.

Among the questions to be addressed are:-

- To what extent does axiophyte data complement and quantify the existing conservation framework?
- Does the data present new insights into conservation objectives?
- Can axiophyte data be used to present a more evidence-based approach to conservation?
- Can the axiophyte data be used to quantify changes in site quality?
- What are the limitations and weaknesses of the axiophyte approach?
- How can the axiophyte system be developed and used in future?

The Meres & Mosses Natural Area

The Meres & Mosses area occupies nearly all of the Ordnance Survey 100km square SJ, east of the Welsh border. A small part of the area is in Wales, in Denbighshire, but that part is not included in the current analysis owing to a lack of available data.

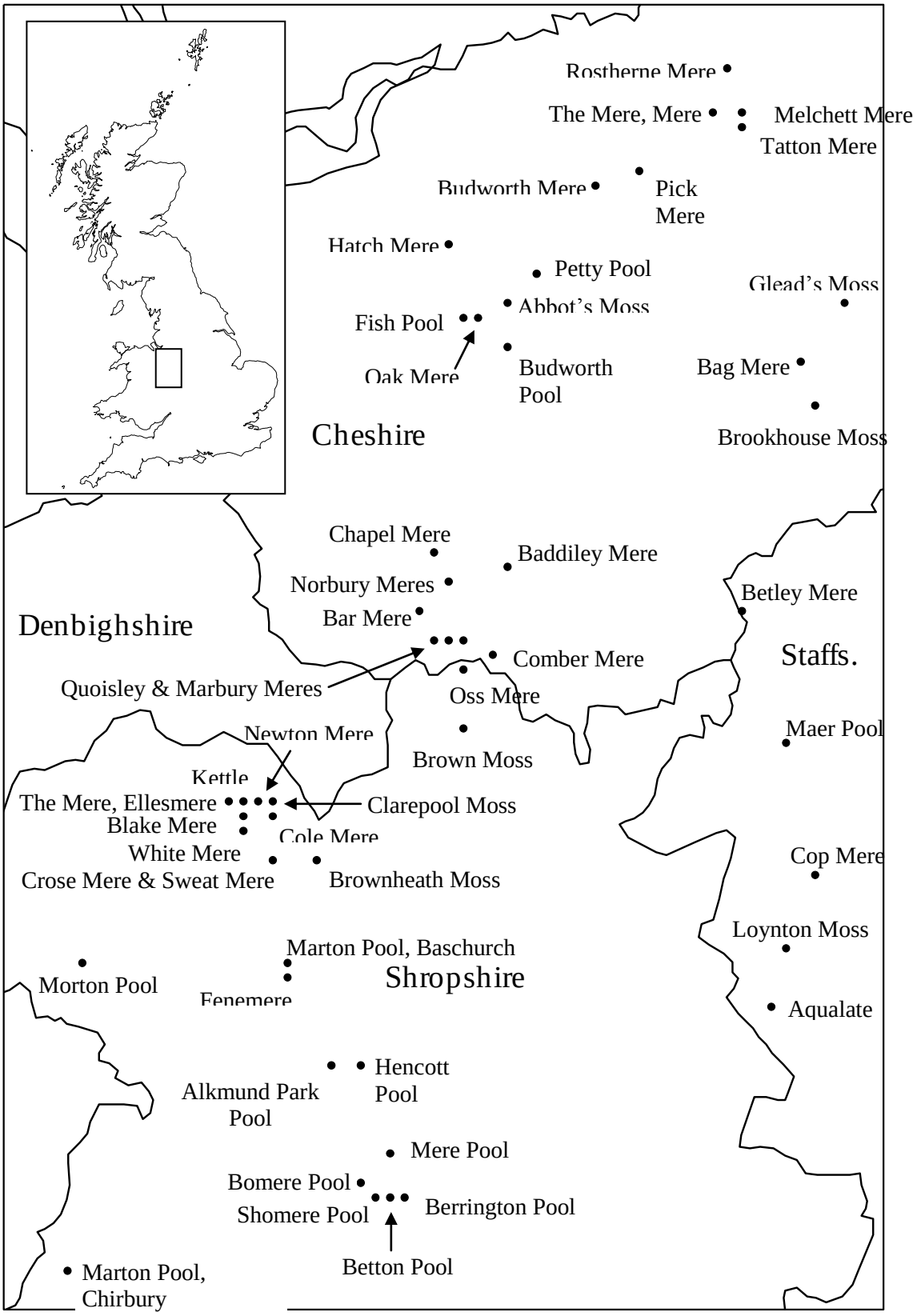

Figure 1: Location of the main Meres

Selection of Species

Axiophytes are species that are indicative of habitats with a favourable conservation status. Using standard techniques for identifying indicator species, a list of species that are typical of the characteristic habitats of the Meres & Mosses was drawn up. These species are:-

- 90% confined to high quality habitat;
- present in 25% or less of the tetrads in each county;
- naturally occurring in one or more of the habitats that are characteristic of the Meres & Mosses, i.e. fen, swamp, mire, open water and wet woodland.

The list was drawn up in consultation with the BSBI county recorders for Shropshire, Staffordshire and Cheshire. Some 109 species were chosen, and 17,747 records for the three counties were extracted from the databases held by the county recorders. Records of subspecies and varieties were merged with those of the species.

Rare species were excluded from the analysis, as were any species that are now extinct from the region, even though they may have been widespread previously. Some axiophytes that are typical of grassland and woodland on dried-out peat bogs were also excluded from the analysis – so only wetland plants were retained.

The scope of the data

There are 80 10km squares in the area covered by this report, and approximately 1,600 tetrads that contain land, on the English side of the border. Some 900 of these tetrads have at least one of the axiophytes recorded in them. The complete list of axiophytes, and the number of tetrads for each, is shown in table 1. The most common species is *Phragmites australis* (Common Reed), which is found in 284 tetrads – about 1/5 of the tetrads in the region. Figure 2 shows its distribution.

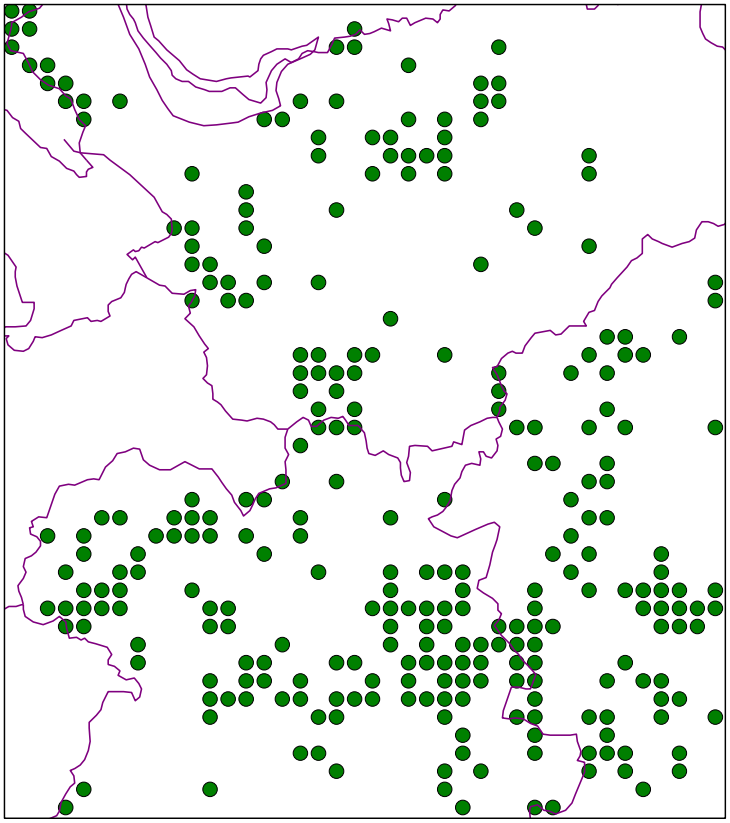

Fig. 2: distribution of *Phragmites australis*, the most widespread of the axiophytes included in this study. Although it occurs in 80% of the wetlands of any quality in the region, it is still only present in 1/5 of all possible sites, which supports the view that it should be considered an indicator species.

Table 1: list of axiophytes included in this study, showing the number of tetrads within the region in which each species is recorded.

Achillea ptarmica	225	Luzula multiflora	192
Agrostis canina	120	Lysimachia vulgaris	132
Alopecurus aequalis	15	Lythrum portula	63
Anagallis tenella	46	Menyanthes trifoliata	103
Andromeda polifolia	24	Molinia caerulea	184
Apium inundatum	46	Myrica gale	15
Baldellia ranunculoides	48	Myriophyllum alterniflorum	15
Berula erecta	149	Narthecium ossifragum	27
Bidens cernua	301	Nuphar pumila	5
Bidens tripartita	136	Oenanthe aquatica	119
Calamagrostis canescens	45	Oenanthe crocata	302
Callitriche hermaphroditica	13	Oenanthe fistulosa	79
Carex curta	46	Osmunda regalis	48
Carex disticha	63	Parnassia palustris	25
Carex echinata	84	Pedicularis palustris	35
Carex elata	51	Persicaria minor	11
Carex elongata	25	Phragmites australis	284
Carex lasiocarpa	16	Polygala serpyllifolia	54
Carex panicea	295	Potamogeton obtusifolius	37
Carex paniculata	240	Potamogeton polygonifolius	43
Carex pilulifera	81	Potentilla palustris	143
Carex pseudocyperus	216	Ranunculus circinatus	29
Carex rostrata	120	Ranunculus lingua	92
Carex vesicaria	67	Ranunculus omiophyllus	48
Carex viridula ssp. brachyrrhyncha	3	Ranunculus peltatus	80
Carex viridula ssp. oedocarpa	100	Ranunculus trichophyllus	39
Carex viridula ssp. viridula	2	Rhamnus cathartica	44
Catabrosa aquatica	42	Rhynchospora alba	20
Cicuta virosa	83	Rumex hydrolapathum	284
Cirsium dissectum	14	Rumex maritimus	54
Cladium mariscus	16	Sagina nodosa	16
Dactylorhiza incarnata	16	Salix aurita	90
Dactylorhiza maculata	36	Salix pentandra	106
Dactylorhiza praetermissa	107	Salix purpurea	65
Danthonia decumbens	122	Salix repens	24
Drosera anglica	18	Salix x meyeriana	12
Drosera intermedia	19	Salix x multinervis	42
Drosera rotundifolia	29	Salix x smithiana	53
Dryopteris carthusiana	114	Samolus valerandi	12
Elatine hexandra	8	Schoenoplectus lacustris	100
Eleocharis acicularis	18	Schoenoplectus tabernaemontani	24
Eleogiton fluitans	21	Spirodela polyrhiza	50
Empetrum nigrum	29	Stachys palustris	378
Erica tetralix	67	Thelypteris palustris	30
Eriophorum angustifolium	79	Trichophorum cespitosum	16
Eriophorum vaginatum	55	Triglochin palustre	112
Frangula alnus	132	Typha angustifolia	89
Galium uliginosum	68	Utricularia minor	19
Hottonia palustris	83	Vaccinium oxycoccos	44
Hypericum elodes	24	Valeriana dioica	116
Isolepis setacea	90	Veronica catenata	94
Juncus foliosus	2	Veronica scutellata	89
Juncus subnodulosus	28	Viola palustris	108
Littorella uniflora	25	Zannichellia palustris	39
Luronium natans	47		

Using axiophytes to identify sites of conservation value

The two tables below show the number of axiophytes recorded in each tetrad, giving the twenty highest scores for all data (table 2) and just the post-1987 data (table 3). This is perhaps the most basic analysis that can be performed using the axiophyte lists – simply counting the number of species present.

By convention, there is no standard cutoff date for inclusion of records in a SSSI citation. All species that have been recorded in a site since it was first surveyed by the Nature Conservancy (often ca. 1948) and its successors tend to be treated as still present. Those that have gone extinct are sometimes planted back in and remain included as features of interest. The axiophyte data includes many much earlier records, and often these are of ecological significance; some species have been known to recur spontaneously after long periods of absence. However, the post-1987 records are probably the most appropriate ones on which to base a current site assessment.

Table 2: the 20 most species-rich tetrads using all data. The right-hand column lists the most prominent site in the tetrad concerned (although not all the species listed for the tetrad necessarily occur in those sites).

Rank	Tetrad	No. species	Main site/s
1.	SJ43C	72	(The Mere, Ellesmere)
2.	SJ43G	62	(Cole Mere)
3.	SJ40Z	60	(Bomere Pool)
4.	SJ65V	58	(Wybunbury Moss)
5.	SJ50D	55	(Bomere, Shomere & Betton pools)
6.	SJ43B	54	(White Mere)
7.	SJ43F	54	(Sweat & Crose Meres)
8.	SJ53U	54	(Brown Moss)
9.	SJ72Q	54	(Aqualate)
10.	SJ57L	51	(Hatch Mere & Flaxmere)
11.	SJ56T	45	(Oak Mere)
12.	SJ78M	45	(Rostherne Mere)
13.	SJ42L	44	(Fenemere)
14.	SJ41Y	42	(Hencott Pool)
15.	SJ32N	41	(Twyford Vownog & Montgomery Canal)
16.	SJ43S	41	(Wem Moss)
17.	SJ50I	41	(Berrington Pool)
18.	SJ43X	40	(Whixall Moss & Prees Branch Canal)
19.	SJ54P	39	(Norbury Meres)
20.	SJ74N	39	(Betley Mere)

Table 3: the 20 most species-rich tetrads using just the post-1987 data

Rank	Tetrad	No. species	Main site/s
1.	SJ53U	46	(Brown Moss)
2.	SJ72Q	42	(Aqualate)
3.	SJ43G	41	(Cole Mere)
4.	SJ43F	36	(Sweat & Crose Meres)
5.	SJ42L	35	(Fenemere)
6.	SJ54P	33	(Norbury Meres)
7.	SJ65V	32	(Wybunbury Moss)
8.	SJ82A	31	(Doley Common)
9.	SJ50D	29	(Bomere, Shomere & Betton pools)
10.	SJ91U	28	(Cannock Chase)
11.	SJ57L	27	(Hatch Mere & Flaxmere)
12.	SJ78K	27	(Tatton & Melchett Meres)
13.	SJ32B	26	(Morton Pool)

14.	SJ43C	26	(The Mere, Ellesmere)
15.	SJ43S	25	(Wem Moss)
16.	SJ50I	25	(Berrington Pool)
17.	SJ74N	25	(Betley Mere)
18.	SJ75K	25	(Balterley Heath)
19.	SJ42F	24	(Walford Pool & The Yesters)
20.	SJ54U	24	(Norbury Meres)

In this analysis it can be seen that the evidence from the axiophyte data largely corroborates the existing system of conservation designation. All but 2 of the top 20 current tetrads contain SSSIs, which are usually (although not always) the sites for most of the axiophytes listed.

Brown Moss is the most species-rich site, and it has the highest level of protection, being a nature reserve, SAC, NNR, SSSI and part of a Ramsar Site. Aqualate Mere also has all these designations and is very similar to Brown Moss in quality.

The two tetrads without SSSIs are SJ43C (The Mere, Ellesmere) and SJ42F (The Yesters), both descheduled SSSIs. Possibly the decision to deschedule them should be revisited.

Using axiophytes to target areas for action

The coincidence map below shows the hotspots for wetland axiophytes in the region. Darker, redder colours show the higher species densities. There are clearly many places throughout the region that contain axiophytes, but the map confims that, based on current knowledge, the SSSIs are by far the most important features.

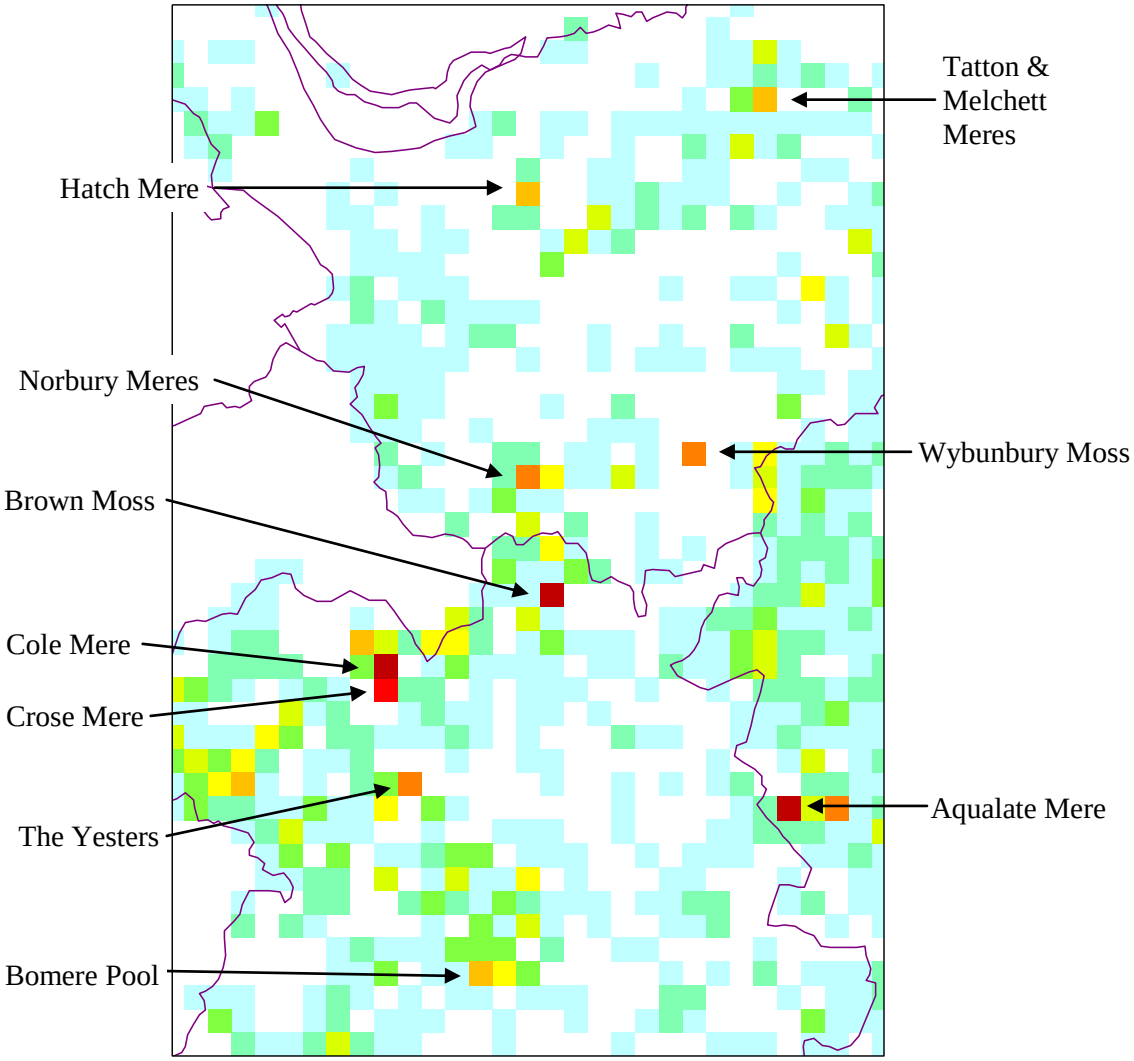

Figure 3: coincidence map of wetland axiophytes in the Meres & Mosses region. Higher number of species are shown by darker, redder colours.

One question that should be addressed is how the species that are characteristic of the Meres & Mosses can best be protected? There are well over 200 meres and mosses identifiable on the map, and many other wetland sites within the region, but only about 50 SSSIs and the conservation resources available to Natural England tend to be concentrated on just a handful of those. Is this the best way to allocate the resources? Is it likely to succeed in protecting the key features of the region?

Of the 109 axophytes selected for study, just 4 are restricted to the top 20 sites. The remaining 104 all occur in the less important sites as well. The exceptions are *Carex viridula* ssp. *brachyrrhyncha*, *Carex viridula* ssp. *viridula*, *Drosera anglica* and *Nuphar pumila*. *Carex limosa* and *Calamagrostis stricta* would also have fallen into this category if they had been

included (but they are too rare nationally). One of these species (*Drosera anglica*) is probably extinct in the region already.

By contrast all but one of the axiophytes occurs in one of the top 20 sites. The exception is *Utricularia minor*, which is recorded at SJ43X & SJ43Y (Whixall Moss) and SJ56Z (Abbott's Moss). This demonstrates that examples of all the important habitat types in the region could be conserved in a small suite of important sites, if necessary; and that the conservation of these sites is essential for the conservation of the all the characteristic species of the region. The rarer species in the Meres & Mosses region would be lost if the small number of key SSSIs were not well protected.

However, with the exception of a few relict rarities, all the other axiophytes of the region occur in less important sites, including many that are not SSSI. It is hard to avoid the conclusion that there is a somewhat arbitrary division between many of the scheduled sites and area of undesignated countryside that are of equal or even superior ecological interest. The boundaries of many SSSIs are also questionable in many instances.

Characterising the vegetation…

The dendrogram below shows a Twinspan analysis of the species in the top 100 tetrads within the Meres & Mosses region. Species are divided into clusters depending on how frequently each occurs in the same tetrad as the others. The aim of this is to be sure that all species assemblages are identified, not just the most species-rich.

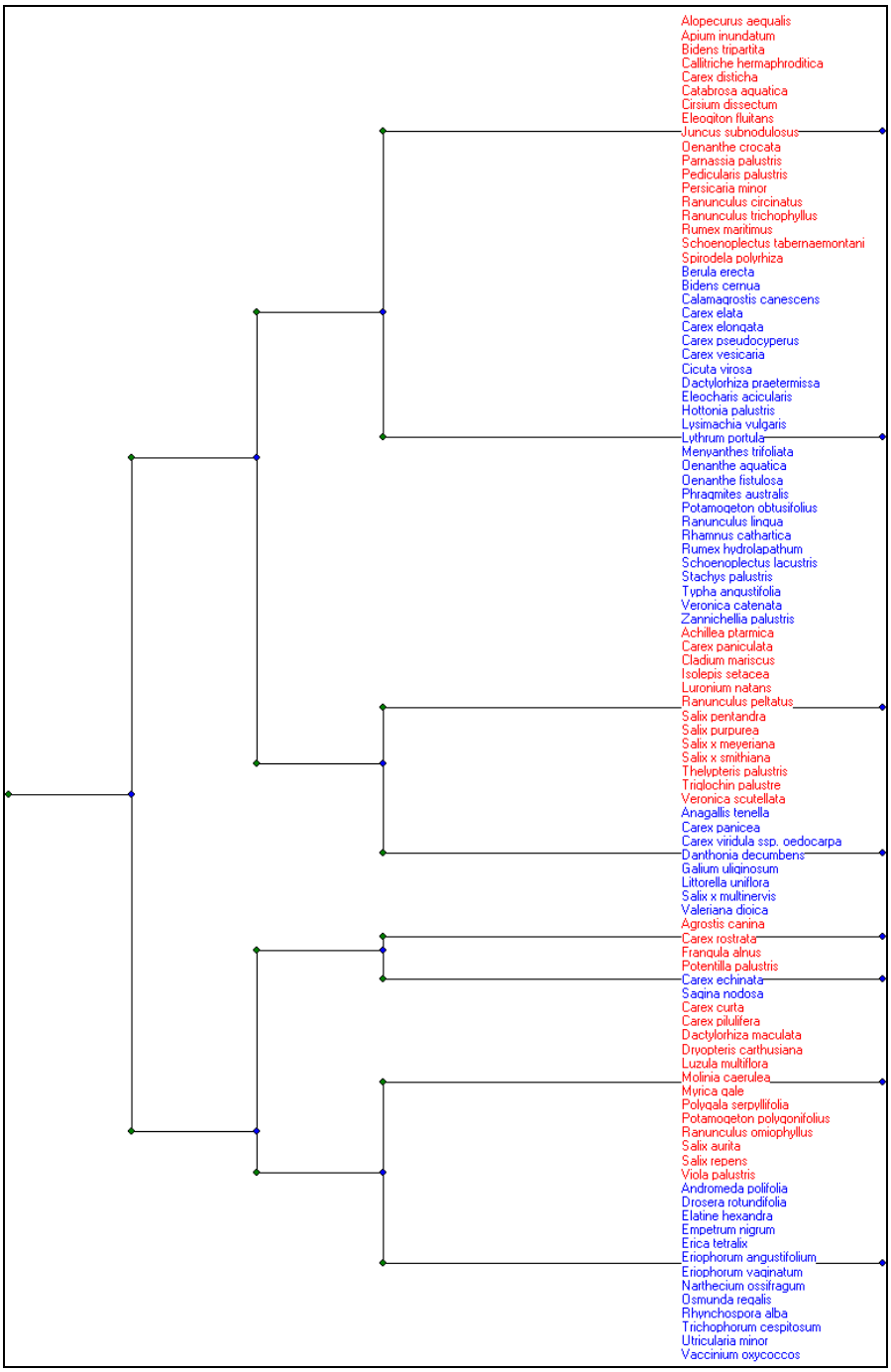

Fig 4: Twinspan dendrogram of the species in the top 100 tetrads.

Identifying opportunities for restoration

Opportunities for the restoration of sites depends largely on the nature of the site in the past and the degree to which it is degraded. This is a complex issue that varies greatly with habitat types, causes of change, and many other factors such as the surrounding land use. Because it is so complex, restoration tends to happen in a rather *ad hoc* fashion depending more upon the availability of suitable sites than on any strategic framework, and success is rare.

The axiophyte data can contribute towards the formulation of a strategic approach for restoration of the characteristic vegetation of the Meres & Mosses region by identifying sites where deterioration has been both dramatic and recent. A high number of axiophytes in the past suggests that restoration would be worthwhile, and it is reasonable to assume that recent changes may often be more easily reversed (although not always – each site would have to be considered individually). The map below shows the sites with the highest loss of axiophytes in the recent past.

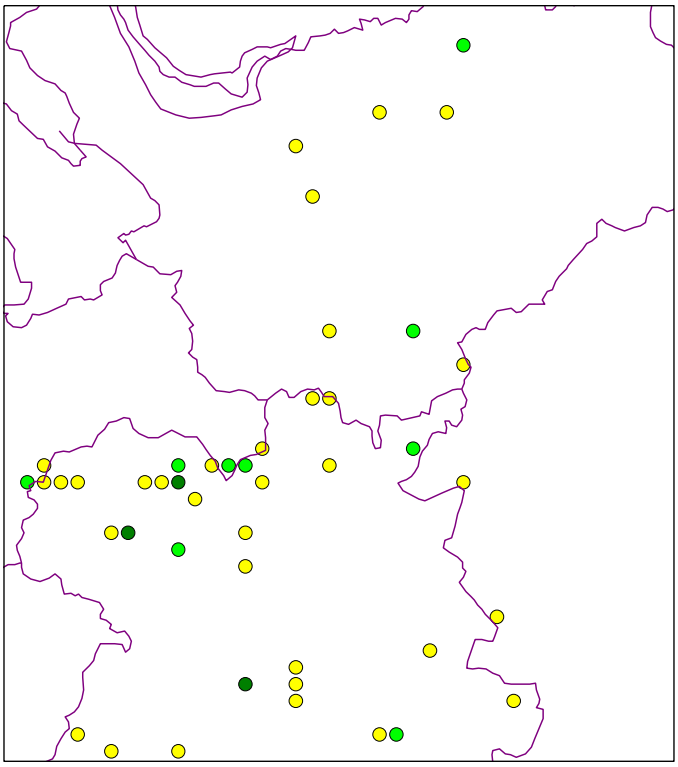

Fig. 5: the sites with the highest rate of loss of axiophytes in the 20th century. The difference between the number of species recorded before and after 1987 shows losses of up to 26 species. Dark green dots show where more than 20 axiophytes have been lost; pale green is where 15-20 species are lost; and yellow dots show all sites where at least 10 species have gone.

The biggest loss has occurred in tetrad SJ43B, which is where White Mere and much of Blake Mere are. A lot of peat bog, with species such as *Andromeda polifolia*, has been lost (in 1957) from this area, and only traces remain, heavily wooded, on the margins of the two meres. Water quality has declined in the meres and in the canal, with the loss of species such as *Littorella uniflora* (1979). Even *Phragmites australis* seems to have gone (1984) as the meres have lost their fringing vegetation.

The restoration of White Mere and Blake Mere would be, ecologically, a straightforward task, and there would be a very high chance of success in restoring many of the lost axiophytes.

Using axiophytes to set objectives for site management

Axiophytes can be used to provide measurable objectives for site management. An example of this might be the recent attempt to restore the vegetation of Clarepool Moss in Shropshire.

Clarepool Moss is notable mainly for being the last site in Shropshire for Bog Sedge, *Carex limosa*, which is a highly specialised bog plant that we considered too rare in this region to include it as an axiophyte in this study. Although the reappearance of this rarity would be a dramatic success, that seems quite unlikely to happen.

However, any attempt to restore the habitat and vegetation at Clarepool Moss could and should include smaller gains. The extent to which the management is successful should be measured according to a predefined set of criteria, rather than retrospectively. Ultimately, a quantifiable measure of progress could be used as part of a cost-benefit analysis of any proposed project. Does the restoration of one species of axiophyte cost £100, £1,000 or £1m? If such a calculation could be performed, it would allow evaluation of various options of widely differing scope, such as the relative efficacy of managing SSSIs as compared with agricultural extensification schemes.

At Clarepool Moss 16 species of axiophyte are considered extant, while 8 species have apparently gone extinct. If the management is successful, the number of axiophyte species should increase, and any further losses should be at least balanced by the number of species gained. If the goal is specifically to recreate lowland raised bog, the gains should be of axiophytes that are characteristic of this habitat. Measuring the abundance of these species would provide an even more sensitive test of change.

Table 4: Axiophytes of Clarepool Moss

1. Extant species	**2. Species believed lost**
Andromeda polifolia	*Agrostis canina*
Carex curta	*Drosera anglica*
Carex panicea	*Drosera intermedia*
Carex paniculata	*Luzula multiflora*
Carex rostrata	*Narthecium ossifragum*
Drosera rotundifolia	*Rhynchospora alba*
Dryopteris carthusiana	*Trichophorum cespitosum*
Empetrum nigrum	*Utricularia minor*
Erica tetralix	
Eriophorum angustifolium	
Eriophorum vaginatum	
Frangula alnus	
Molinia caerulea	
Osmunda regalis	
Potentilla palustris	
Vaccinium oxycoccos	